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# PETROLOGY.—*Some magmatic problems.*[1]

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For many years the causes of magmatic differentiation have been a subject of very great interest to petrographers. As much as a hundred years ago Scrope suggested that a main cause of variation of magmas was to be found in the sinking of early formed crystals, and Lyell believed this to be the true explanation. Later, various other explanations were advocated by different students, but there was no general agreement as to their efficacy or applicability. The theories were expressed in rather vague general terms and lacked precision.

Comparatively recently N. L. Bowen has shown, by skilful laboratory work and admirable reasoning, in just what manner the separation of successive solid phases from a silicate melt should modify the composition of the residual liquid, and the way in which the results might be applied to natural magmas. His views have gained wide acceptance, and probably most petrologists now regard the essential problems of differentiation as solved.

There is, however, a danger that in the enthusiasm aroused by a notable advance, expectation will be too great, and the possibility of the operation of other processes will be overlooked. There are some geologists who are not yet prepared to accept all the implications of this theory of differentiation, and who feel that it would be well to proceed a little more cautiously and to test more carefully by field observations whether all its requirements are met. They would ask its advocates to give consideration to some apparent discrepancies and endeavor to bring them into accord. It is my purpose to describe certain occurrences that seem incompatible with some of the requirements of the theory as heretofore enunciated. It is hardly necessary to emphasize that our whole conception of the properties of magmas

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and of the processes operating in the depths of the earth are involved in the question of differentiation.

All petrologists are familiar with the general principles of the theory of differentiation by crystal separation, but I wish to call special attention to one or two of its main points. It is supposed that the magma that begins to differentiate is basic, probably basaltic. As this cools, crystals separate, and by their separation the composition of the remaining liquid is caused to change progressively. In the normal sequence the liquid passes from basalt through increasingly siliceous andesitic types to a very siliceous rhyolite. The points to be noted are that rhyolite is the *coolest* liquid of the series, and that basic constituents have been eliminated by a *freezing out* process. It follows necessarily that if rhyolitic magma should engulf fragments of basic rock it should not be able ordinarily to melt them or take them into solution, as the minerals of such basic rocks are almost wholly of the sort that, theoretically, have already been frozen out of the magma in the process by which rhyolite has been generated. This idea has been regarded by many writers as almost axiomatic. Accepting unreservedly the view that rhyolites have been formed in this manner and only in this manner, they reason that it would be as illogical to suppose that rhyolite magma could dissolve basic rocks as that a salt solution that had deposited crystals could automatically reverse the process and redissolve the crystals.

On the other hand, in the course of field work, I have come across two remarkable occurrences in which there seems to have been direct solution of large amounts of basic rocks in rhyolite. The incompatibility of these phenomena with theoretical expectations seems to place before petrologists a problem requiring solution before we can be satisfied that the orthodox scheme of differentiation is broad enough to cover all phases of the subject.

The first of these occurrences was met in the Katmai region. At the time of the great eruption of Katmai, the main activity was in the central crater, but important manifestations occurred in the nearby area known as the Valley of Ten Thousand Smokes. We believe that these subsidiary outbreaks had their origin in an intrusive sill that was thrust into the horizontal Jurassic sediments that underlie the valley, and broke through to the surface at numerous points. The chief of these secondary eruptive centers was at Novarupta.

From the nature and distribution of the ejected material of the eruption the chief events may be stated as follows:

At the main crater of Katmai enormous quantities of pumice and

lapilli were ejected in violent explosions, and carried to great distances. At the vents in the Valley of Ten Thousand Smokes the violence was much less, but pumiceous material frothed over the rims and was swept down the Valley in one or more incandescent floods that resembled the glowing clouds of the West Indian eruptions; these we have called the hot sand flows. Novarupta, at the head of the Valley, participated in this phenomenon and was probably a chief contributor to the sand flows. Later, it shot up a spray of fiery fragments which were deposited in thick beds in its immediate vicinity and built up an encircling wall. Its last act, most important for the information on assimilation that it gives, was the slow extrusion of a mass of viscous, glassy lava, which became rigid on the surface as it cooled, and broke into great blocks from the effect of the uplifting forces. This material represents what might be termed a gigantic quenching experiment. It shows in diagrammatic manner the processes of solution and incorporation of xenolithic blocks, arrested at a stage of incomplete digestion by the congealing of the mass.

The new, live magma ejected at Katmai crater and at all the other vents is a very siliceous rhyolite with about 77 per cent silica. Specimens of uncontaminated lava from Katmai, from Novarupta, and from the Valley have been analyzed by several chemists, and they show an almost identical composition. Moreover, there is good reason to believe that the composition of the live magma rising from the depths remained constant from beginning to end of the eruption. Where variations occur there is direct evidence of near-surface contamination.

At all the vents, however, contamination seems to have taken place on a large scale and in similar fashion. Evidence might be cited for each, but it is at Novarupta that it is most easily and convincingly demonstrated.

The uncontaminated rhyolite pumice emanating from all of the vents is a typical pumice, greatly inflated and almost white. It differs much in appearance from the minutely vesicular rhyolitic glass of Novarupta, but this is due simply to their different degrees of inflation. The only crystals that appear in either are rare phenocrysts of quartz and oligoclase. Where the rhyolite has become contaminated the undigested xenoliths have usually the composition of basic andesites of various kinds, and the textures of surface lavas, though sedimentary fragments are fairly plentiful, and there are inclusions of plutonic rock.

The contaminated pumice of the early phases of eruption, which is

found in abundance, shows alternations of white and black bands. The black bands, which are sharply contrasted with the white, contain numerous phenocrysts of labradorite, pyroxene, and magnetite in a brown glass, but in the final stages of reaction these phenocrysts almost disappear in solution, and the siliceous and basic liquids become thoroughly mixed.

In many specimens it is evident that not only was the basic material melted down, but it became so thoroughly impregnated with gases that it participated in the inflation to a pumiceous froth.

These variegated and banded pumices plainly show a remarkable association of two sharply contrasted types of lava, but because of the fragmental nature of the pumice, such material is not well adapted to show how the basic bands originated. Novarupta supplies to perfection the missing evidence. The rock that forms the dome represents the closing stages of activity. The violently explosive phenomena had subsided, and though the rock is shattered, the blocks are large enough to exhibit the mutual relations of the heterogeneous constituents.

Novarupta forms a nearly circular pile of lava about 800 feet in diameter, consisting of rock that is banded on a large scale. Associated with the dark bands and evidently the source from which they originated may be seen thousands of basic xenoliths in all stages of digestion. Some still preserve a sharply bounded, angular outline, but the process of digestion stopped just as others had become softened and were tending toward an elongated form, and as fragments were floating away. Still others reached the stage of disintegration at which they formed lenticular masses of scoria, and finally nothing was left but dark bands. Some of the bands extend for many feet, but at their terminations they always wedge out into the rhyolite. There is no reason to doubt that the rhyolite is the all-embracing matrix and that the dark bands represent included material. Furthermore, the separation between light and dark bands is usually abrupt. This could hardly be so if the two had been stirred together in a violently agitated pool of lava, nor could such a separation have survived the turbulent mixing that the constituents would have undergone, if the basic material had become involved in the rhyolite during its rise from the depths. For this reason, and because the basic material itself has the characteristics of surface andesites, it is believed that the contamination is a near-surface phenomenon.

The features described characterize all the rock of the dome. The specimens and photographs exhibited demonstrate more effectively

than descriptions the processes that were in operation just prior to the congealing of the Novarupta lava. Microscopic examination of this contaminated material shows undoubted evidence of solution, but the best evidence on a microscopic scale is obtained from certain specimens that belong to an earlier stage of activity, when solution was probably going on more vigorously; these were thrown out during the explosive phases.

In thin sections of these specimens some of the minute xenoliths still have a definite form, though the boundaries are very irregular in detail. In many of them the original texture is preserved, and they may be recognized commonly as basic andesites, less often as sediments. Some of the xenoliths became softened, and their shape was distorted. Some were even drawn out into long tongues. The groundmass progressively lost its textural characteristics and became a dark brown glass which has an index of refraction appropriate to an andesitic glass.

Contrary to what we might expect, we find that basic xenoliths were softened and dissolved with more ease than those having the composition of acid andesites.

Further mixture of rhyolite magma and basic liquid is seen in thin sections to present an extremely streaky appearance, and irregular, dark clots are numerous. The phenocrysts of the inclusions consist of pyroxene, iron ore, and plagioclase. Less often hornblende and biotite appear. The phenocrysts were somewhat more resistant to attack than the groundmass, and many of them became free and floated away, but they too yielded to attack and became much corroded, especially the feldspars.

Commonly the feldspars have the composition of acid to basic labradorite, and are much zoned in oscillatory fashion. In their destruction many show a curious effect. The interiors became riddled with brown glass, which had a decided preference for the more calcic zones. This form of replacement went so far that while the outlines of the crystal were preserved, the whole interior, except for small islands of unreplaced feldspar, concordantly oriented, consists of isotropic glass.

In the thick deposits of ejecta from the main crater of Katmai, xenoliths and banded pumices are present, as at Novarupta, but, on the whole, digestion of xenoliths has been much more complete, especially in the later pumices. They carry phenocrysts of labradorite, pyroxene, and ore, from which the matrix has been wholly dissolved away, uniformly dispersed through a frothy glass. Little bipyramids

of quartz are also present, as witnesses of the rhyolitic partnership in the combination, and the bulk composition of the mixture, as shown by analyses, is that of an acid andesite. It does not seem possible to escape the conclusion that in the vents of the Katmai region rhyolite magma melted down and incorporated a large quantity of basic rock. It is especially noteworthy that the introduction of this cold material into the magma, and its assimilation, did not cause precipitation of crystals in the rhyolite. A large amount of heat must have been available, either as excess temperature or as heat of reaction.

I will now take up the second example of assimilation of basic rocks by rhyolite to which I have referred. This was found along Gardiner River in Yellowstone Park. Here many of the conditions were very different from those in the Katmai region, and the resulting phenomena differ in many respects, but assimilation is equally remarkable.

At this place Gardiner River forms the boundary between a wide area of basalt on one side and a still wider area of rhyolite on the other. Both are believed to be of Upper Tertiary age, but the basaltic flow occurred long enough prior to the rhyolite for erosion to produce a surface of considerable relief. At this particular place there was evidently a steep, eastward-facing slope of basalt, with small ridges and other minor irregularities rising from it, and probably with accumulations of boulders lying on its surface and at its foot. From some unknown source enormous extrusions of rhyolite were poured out, which advanced upon this slope and flooded it. Subsequent erosion has worn down the surface in the vicinity so that it is now a nearly level plain, and, what is a very fortunate circumstance, Gardiner River has cut a steep-sided little valley or gorge at just the place best suited to show the contact phenomena.

The contact is very irregular in detail, but, in general, basalt occurs along the sides of the gorge at lower levels whereas the contaminated rhyolite is at higher levels. Small ridges and knobs of basalt protrude through the rhyolite. A little farther back from the river on the west is the wide area of basalt and on the east that of rhyolite. Exposures along the rocky gorge are excellent for a distance of 1,500 feet.

The contaminated rhyolite along the contact contains myriads of basalt xenoliths, ranging in size from those several feet in diameter down to minute chips. These show varying degrees of digestion, and the rhyolite shows varying degrees of contamination. Probably some of this xenolithic material was derived from loose blocks, but certainly not all of it, for the rhyolite had remarkable powers of penetra-

tion. This is plainly demonstrated by the way in which it found its way into the basalt, which is penetrated in places by veins of rhyolite of paper-like thinness. The magma also soaked into some of the inclusions almost as if it were water, and by some process of interchange of constituents not fully understood, the xenolith, while preserving a definite outline, was replaced by rhyolite until only a dim phantom was left. Multitudes were acted upon in this manner, but great quantities of others were disintegrated and incorporated in the rhyolite.

A very remarkable effect is found in a number of places in the exposures along the rocky walls of the gorge. In a typical exposure the rock at the top of the bluffs, 30 feet or so above the water, is largely rhyolite. As we descend the slope, the proportion of rhyolite decreases irregularly, and that of basalt increases, until most of the rock is solid basalt, but this is cut by ramifying and anastomosing veins or dikes of rhyolite. Such dikes locally attain a foot or more in width, but many of them are narrow seams. The rhyolite in these may be quite pure or may be much contaminated with basalt and have an intermediate composition. The dikes decrease in size and number going downward, and at the water's edge very little rhyolite is found. We have here a strange case of a lava flow becoming an intrusive.

In another place, nearly vertical cliffs, 15 or 20 feet high, are composed essentially of unaltered basalt, but locally this is penetrated in the most intricate and irregular manner by more or less contaminated rhyolite. This injected material is in small to minute veinlets. Both the rhyolite and the hybrid rock contain numerous vesicles lined with tridymite crystals, and the passage of gases is indicated by open pockets and pipes of irregular shape. The vertical zone of basalt penetrated in this manner by rhyolitic liquids and gases has a width of 1 or 2 up to 4 or 5 feet. It is made up of rhyolitic veins, seams, and bands; basalt fragments; and hybrid material, inclosed in walls of solid basalt. Forty or fifty per cent of basalt in the mixture is not unusual. In places irregular, dike-like offshoots of rhyolitic affinity extend into the walls, but individually they have no great length and soon fade out.

In some places a zone or system of dikelets of this character has penetrated 40 or 50 feet downward into basalt.

At one place at the top of the cliffs a mass of normal-looking rhyolite with gently inclined flow banding sends out a horizontal tongue, 3 or 4 feet thick, under a capping of basalt for a distance of several feet, and appears much contaminated. Then it becomes thinner and is succeeded by a network of rhyolite veins in basalt. Immediately

adjacent, a vertical pillar of basalt is bounded by rhyolite on the two exposed sides. The rhyolite is contaminated at the contact but has a normal appearance a few feet away.

Minor effects are seen that suggest the action of gases distilled from the rhyolite into the basalt rather than the action of liquid rhyolitic magma. Certain small xenoliths of basalt inclosed in very vesicular, tridymite-bearing rhyolite became granular and porous, and minute tridymite scales were deposited in the pores.

This penetration of veins of rhyolite into solid basalt for long distances indicates a remarkable mobility of the rhyolite magma, even if we assume that it was forced into seams of the basalt under great pressure of overlying magma. This mobility may be ascribed to its high content of volatiles. What seems almost unbelievable is the ability shown by the small tongues of magma that penetrate 25 to 50 feet downward into masses of basalt within narrowly confining walls to heat up and assimilate considerable quantities of cold rock, but the relations seem to leave no room for doubt.

Great powers of assimilation are likewise shown by certain large masses of rock at the top of the cliffs, well above the solid basalt. These are composed of material in which contamination and assimilation progressed so far that a uniform-looking, nearly aphanitic mixture resulted. They have a color ranging from medium gray to a shade nearly as dark as the basalt itself. Their appearance is that of fine-grained andesites. Analyses were made of two homogeneous-looking specimens of this hybrid rock. One has a composition corresponding to 30 per cent basalt and 70 per cent rhyolite, and the other to 69 per cent basalt and 31 per cent rhyolite. The heat necessary to assimilate such large amounts of basalt may have been supplied in part by overlying magma, but this explanation is hardly applicable to the dikelets of rhyolite that penetrated long distances downward into masses of cold rock, corroding and assimilating as they went. These phenomena seem to require either a very highly superheated magma or the development of heat by chemical reactions, but both of these suppositions are excluded in the theory of crystal differentiation as it has been formulated. We seem to have evidence everywhere in this area of the ability of the rhyolite to accomplish things that the theory of crystallization differentiation has declared to be impossible.

Microscopic examination of the rocks confirms in every way the inferences derived from field studies. In the contaminated rocks thin sections reveal inclusions of basalt in rhyolite in various stages of reaction and disintegration. Their borders became greatly corroded,

and fragments floated away in the liquid. In these fragments the minerals of the groundmass commonly underwent partial disintegration, the inclusion taking on a sooty appearance, and in the later stages of solution only sooty specks were left. Phenocrysts in the basalt were set free and became distributed through the rhyolite, but though they persisted longer than the groundmass, they also were attacked.

In the hybrid rocks in which assimilation was so complete that they appear homogeneous, the microscope shows a strange assemblage of minerals indicative of their hybrid origin. Taking as an example the specimen previously mentioned as having a composition equivalent to 70 per cent rhyolite and 30 per cent basalt, we find corroded phenocrysts of olivine, pyroxene, and labradorite derived from the basalt xenoliths, together with quartz and sodic orthoclase derived from the rhyolite magma, scattered through a perfectly uniform-textured fine groundmass derived from mutual reactions. It consists of pyroxene, ore, oligoclase, and orthoclase. In most places in the section all evidence of xenolithic inclusions has disappeared, though here and there traces persist in small, dimly perceptible areas which are a shade darker than the rest. Some of these form narrow borders to clusters of basic xenocrysts, but most of the xenocrysts were freed from their original matrix.

I believe that sufficient evidence has been given to show that both in the Katmai region and in Yellowstone Park rhyolitic magma has been able to dissolve large amounts of basic andesites and basalts. The question may be asked as to why such phenomena have not been more commonly described. The explanation is doubtful. They may have been overlooked or they may be very rare. It is hardly to be expected that a magma appearing at the surface will long retain the temperature required to produce such effects. Also, there are indications that the retention of volatiles is an important factor in the process. Ordinarily lava flows quickly give up their volatiles, but for some strange reason the volatiles are sometimes retained for a long period. Both in the Katmai region and in Yellowstone Park the lavas evidently contained a large amount of volatiles, for they were in a very mobile state at the time that assimilation occurred. This implies in turn that the inner equilibrium appropriate to the small external pressure had not been attained.

When we consider these factors, it does not appear likely that lava flows will often show such results as have been described. The important fact, however, is that they are sometimes capable of producing them.

With plutonic magmas of similar composition it is different, and we might more commonly expect solution. As a matter of fact, granitic bodies show phenomena that might reasonably be interpreted in this manner, but ordinarily investigators have been so convinced of the impossibility of such a process that they have preferred to look for other explanations. Though contamination or hybridization of granites has been frequently recognized as an obvious fact, it has been explained as due to a mechanism by which basic minerals that are out of equilibrium with the acid magma are dissolved in only infinitesimal portions at a time, and new minerals are simultaneously precipitated; in other words, it is the process formulated by Bowen in the reaction principle. This is an important principle and must frequently be operative. When the amount of basic rock is small in comparison with the acid magma, the heat requirements of this process are not excessive, and it is not incompatible with the theory of crystallization differentiation. It has frequently been invoked, but, without depreciating its value when properly applied, we may say nevertheless that it has been used by many writers as a facile means of solving difficulties and of explaining almost everything in the way of assimilation. From the nature of its postulated action it is almost impossible to disprove its application in plutonic bodies in any specific instance, whatever may be the truth of the matter. We should have to show that the disappearance of basic minerals is a process of true solution and is not accompanied simultaneously by the precipitation of new minerals farther along in the reaction series. However, when one observes such opposing phenomena as the common persistence of zoned feldspars in magmas, which illustrate the lack of equilibrium that the reaction principle is supposed to correct, one may doubt whether the principle is as universally operative as has been assumed, but doubt is not disproof. In the Yellowstone rocks, however, the amount of contamination is so great and the phenomena are of such a nature that it seems out of the question to explain the results by this principle. Especially in the veins of rhyolite that penetrated many feet downward into basalt, does it not seem certain that the chilling effect of mere contact with cold walls and xenoliths, to say nothing of assimilation, would be far beyond the capacity of the rhyolite magma to meet unless there were inherent in it heat reserves not recognized in the theory of crystallization differentiation? It seems still more apparent that the reaction principle cannot explain assimilation in the Katmai lavas, for here no precipitation of new minerals occurred—the contaminated lava remained a liquid.

Harker has described beautiful examples of hybrid effects at the contact of granites and granophyres with basic rocks on the island of Skye. Some of the phenomena described by him, such as phantom xenoliths and the penetration of threads of magma into the walls, are matched by those of Yellowstone. In spite, however, of his observation of obvious assimilation on a very considerable scale, he is impressed with the great difficulty of accounting for the solution of any large amount of cold rocks by the new magma. He has written: "The insuperable difficulty to any such theory is that it demands an enormous amount of heat to raise the solid rocks to the point of melting and to melt them." He therefore explains the phenomena on Skye by supposing that the injected rocks were still hot or even partly fluid when the new injections occurred. The evidence for this is not altogether convincing, and it looks as if he had felt forced to make this assumption.

The problem of the heat supply may be freely admitted to be one of great difficulty. A number of writers have recognized that the same problem exists in other phases of volcanism, where it is equally striking. The suggestion has been made that the development of heat is essentially a surface phenomenon, due to the combustion of escaping gases or to the oxidation of ferrous iron in the magma. However, combustion of gases that have left the magma does not develop heat in the place where it is required, and in neither the Katmai nor the Yellowstone hybrid rocks was the ferrous iron oxidized. Chemical analyses and microscopic examination show that beyond doubt. Exothermic heat reactions within the magma itself have also been discussed, and diametrically opposing conclusions have been reached. I doubt if this process has been by any means thoroughly explored; in fact, our knowledge is far from complete regarding the state of combination of the silicate constituents and the dissolved gases in magmas, or of the reactions that take place when the magma rises from a region of great pressure to one of little pressure. In the Katmai and Yellowstone lavas the presence of a considerable amount of volatiles is indicated, and this points to a state of delayed equilibrium. Whether the reactions that finally ensued, permitting the volatiles to escape, were exothermic or not, is a question that must await further information.

However, in these hypothetical exothermic reactions there may possibly be found a means of reconciling phenomena of assimilation with the theory of crystallization differentiation. We may suppose that a rhyolitic magma is formed at depth by the freezing out of basic

phenocrysts. It is therefore a relatively cool liquid; but it may contain within itself latent possibilities of exothermic reactions, which are developed by the change of equilibrium consequent upon its rise to the surface and the escape of volatiles. By this means it may be reheated to such a degree as to be enabled to take into solution the very minerals that had been precipitated.

This is highly speculative, and even if it represents some approximation to the truth, it necessitates a considerable revision of ideas that have been based upon a theory in which such a conception has found no place.

Moreover, if it should eventually be found that exothermic reactions supply a source of heat for assimilation, this fact would not necessarily be dependent upon the generation of rhyolitic magma by crystallization differentiation, or have any relation to it. It would leave the question open as to how rhyolites have been formed.

Without going farther into this, if the phenomena that have actually been observed have the meaning they seem to have, large amounts of basic rocks were dissolved by the rhyolites. In whatever manner this may have been accomplished, it is not satisfactorily explained by current theories. Many subsidiary problems relating to magmas are likewise involved. I will leave all these for future consideration, only expressing the belief that the important requirement now is to examine without bias the facts as they are found in the field.

CHEMISTRY.—*3, 4-dimethoxy-5-chloro-benzylidene di-amides.*[1] RAYMOND M. HANN. (Communicated by ATHERTON SEIDELL.)

Noyes and Forman[2] have recently studied the reactions of a number of liquid aldehydes with acetamide and isolated the resulting aldehyde di-amides. The purpose of the present investigation was an extension of the reaction to include a solid aldehyde and a variety of acid amides.

Raiford and Lichty's[3] orientation of the mono-chloro vanillins provides a foundation for the preparation of chloro veratric aldehydes of known configuration. Methylation of 5-chloro vanillin has yielded 5-chloro veratric aldehyde and this has been condensed under suitable conditions with acetamide, propionamide, n-butyramide, n-capramide and benzamide.

[1] Received December 2, 1933.
[2] NOYES and FORMAN. J. Amer. Chem. Soc. 55: 3493. 1933.
[3] RAIFORD and LICHTY. J. Amer. Chem. Soc. 52: 4576. 1930.

## EXPERIMENTAL

*5-Chloro veratric aldehyde (3, 4-dimethoxy-5-chloro benzaldehyde).* 50 grams of 5-chloro vanillin was dissolved in 150 cc. 10 per cent NaOH and 600 cc. $H_2O$, heated to complete solution of the separated sodium salt, cooled and held at 35° C., 100 cc. of dimethyl sulfate added to the constantly stirred solution, and the solution maintained alkaline to phenolphthalein by addition of 10 per cent NaOH (10 cc. every 3 to 5 minutes, a total of about 1400 cc. being required). When about 250 cc. of NaOH had been added on oil separated and was brought into solution by addition of 50 cc. more dimethyl sulfate. When this second portion of sulfate had reacted the alkaline solution again separated an oil and on cooling this solidified. The solid was filtered off, washed with $H_2O$ and the filtrate acidified, and 3.7 grams unchanged chloro vanillin recovered. Yield of crude material 50 grams; quantitative. The substance was recrystallized from 50 per cent alcohol for analysis.

5-Chloro veratric aldehyde crystallizes in colorless, soft, glistening needles, and melts to a clear colorless oil at 57° C. (cor.).

*Analysis*: 0.2182 gram gave 0.1553 gram AgCl equivalent to 17.61 per cent Cl. Theory for $C_9H_9O_3Cl$ = 17.68 per cent Cl.

*5-Chloro-veratrylidene di-amides.* One molecular portion of aldehyde, two of the desired amide, and 1 cc. of glacial acetic acid were heated at 140° C. in a small flask for 15 hours. Water was given off when acetamide and propionamide were used and a solid brown cake resulted. The other amides gave brown liquid melt which solidified on cooling. The melt was brought into solution by refluxing with alcohol and filtered through char. The colorless filtrate soon separated crystalline material which was filtered, washed with alcohol, recrystallized from alcohol to constant melting point, and analyzed. The yields are almost quantitative. The data are summarized in table 1.

TABLE 1. PROPERTIES OF 3, 4-DIMETHOXY-5-CHLORO-BENZYLIDENE DI-AMIDES

| Product 3, 4-Dimethoxy-5-Chloro Benzylidene | M. P. °C. (cor.) | Appearance | Nitrogen Analysis Per cent | |
|---|---|---|---|---|
| | | | Calc'd. | Found |
| Di-acetamide | 244–5 | Colorless, crystalline powder | 9.32 | 9.23 |
| Di-propionamide | 235 | Colorless fine acicular needles | 8.52 | 8.30 |
| Di-n-butyramide | 204–5 | Colorless, glistening platelets | 7.85 | 7.50 |
| Di-n-caproamide | 172–3 | Colorless needles | 6.79 | 6.76 |
| Di-benzamide | 217 | Brilliant, soft, colorless needles | 6.60 | 6.63 |

SUMMARY

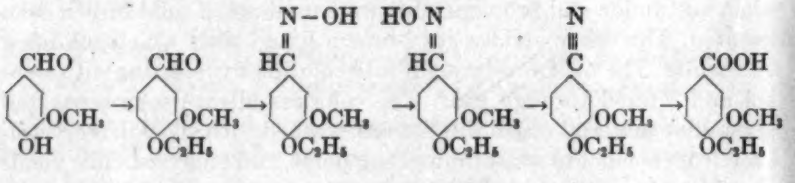
The aldehyde amide condensation reaction has been extended to include a solid aromatic aldehyde with various aliphatic amides.

CHEMISTRY.—*The isomeric oximes of ethyl vanillin.*[1] RAYMOND M. HANN. (Communicated by ATHERTON SEIDELL.)

Ethyl vanillin (3-methoxy-4-ethoxy benzaldehyde) has long been known, having been prepared by Tiemann[2] in connection with his exhaustive research upon the structure of coniferin. The original method of preparation, the interaction of vanillin and ethyl iodide in the presence of ethyl iodide, has since been displaced by the cheaper and simpler method of ethylation by diethyl sulfate in alkaline solution.[3]

In furthering an investigation upon the relationship between structure and taste in the vanillin series it was desired to investigate some properties of the syn-oxime of ethyl vanillin. Because it was necessary to prepare the anti-oxime, it seemed desirable to continue the study of these derivatives and to correlate them with some known compounds of the ethyl vanillin series.

The present paper reports the result of these investigations, and outlines the indirect synthesis of ethyl vanillic acid in accordance with the following series of reactions.




EXPERIMENTAL

*Ethyl vanillin (3-methoxy-4-ethoxy benzaldehyde).* Twenty-five grams of vanillin were dissolved in 75 cc. of 10 per cent NaOH solution and 200 cc. of $H_2O$ added. To the constantly stirred clear yellow solution 45 cc. of practical diethyl sulfate (theory for 2 moles. 42.8 cc.) were added and the suspension gradually heated to 65° C. when reaction occurred. The solution was maintained alkaline to phenolphthalein by addition of increments of 10 cc. 10 per cent NaOH at

[1] Received December 2, 1933.
[2] TIEMANN. Ber. Deutschen Chem. Gesell. 8: 1128. 1875.
[3] BARGER, EISENBRAND, and SCHLITTLER. Ber. Deutschen Chem. Gesell. 66: 453. 1933.

approximate five minute intervals, a total of 70 cc. being required. The solution was then heated rapidly to boiling, 100 cc. $H_2O$ added and upon cooling to 50° C. crystallization occurred. When cold, the ethyl vanillin was filtered and dried. Yield 24 grams. A second crop of 0.8 gram crystallized from the other liquor. Total yield 24.8 grams or 84 per cent of theory. This material was used directly for further work. Recrystallization from 4 parts of 50 per cent ethyl alcohol gave a product melting at 65° C. (corr.) in agreement with Tiemann.

*Ethyl vanillin anti-oxime.* Twenty grams of crude ethyl vanillin, 8 grams of hydroxylamine hydrochloride, 10 grams of sodium bicarbonate and 50 cc. of 95 per cent alcohol were heated under reflux for one half hour. The addition of 200 cc. $H_2O$ caused separation of an oil which rapidly solidified. Cooled, filtered, and recrystallized from 4 parts of 50 per cent alcohol the oxime was obtained in colorless granular prisms which melt at 102° C. (corr.) to a clear colorless oil.

*Analysis:* 0.1137 gram consumed 5.80 cc. 0.1 N acid equivalent to 7.14 per cent N. Theory for $C_{10}H_{13}O_3N$ is 7.18 per cent N.

*Ethyl vanillin anti-oxime acetate.* One and nine-tenths grams of the anti-oxime was heated to boiling with 10 cc. acetic anhydride, the excess anhydride decomposed by $NaHCO_3$, and the separated solid recrystallized from 50 per cent alcohol. The compound crystallized in fine glistening prismatic crystals which melt at 69° C. (corr.) to a clear colorless oil.

*Analysis:* 0.0694 gram consumed 2.9 cc. 0.1 N acid equivalent to 5.85 per cent N. Theory for $C_{12}H_{15}O_4N$ is 5.91 per cent N.

*Ethyl vanillin syn-oxime.* Twelve grams of crude ethyl vanillin anti-oxime was dissolved in 150 cc. ether and the hydrochloride precipitated by introduction of dry HCl and 25 cc. $H_2O$, and the suspension added to a solution of 25 grams of $Na_2CO_3$ in 250 cc. $H_2O$. An oil came down which rapidly solidified. Yield 10 grams. The solid was recrystallized several times from 50 per cent alcohol, and finally obtained in colorless brilliant crystals which melt at 98° C. (corr.) to a clear colorless oil.

*Analysis:* 0.1069 gram consumed 4.5 cc. 0.1 N acid aquivalent to 7.21 per cent N. Theory for $C_{10}H_{13}O_3N$ is 7.18 per cent N.

*Ethyl vanillonitrile (3-methoxy-4-ethoxy benzonitrile).* Five grams of ethyl vanillin syn-oxime was dissolved in 10 cc. acetic anhydride, heated to 30° C., and allowed to stand for ten minutes. The excess anhydride was decomposed by addition of 200 cc. 10 per cent $Na_2CO_3$ solution and the separated nitrite filtered and washed with $H_2O$. Yield 4.5 grams. Recrystallized from dilute alcohol it melted at 102° C.

in agreement with Keffler[4] who prepared it by the action of ethyl iodide on the potassium salt of ethyl vanillin.

*Ethyl vanillic acid (3-methoxy-4-ethoxy benzoic acid).* One gram of ethyl vanillonitrile was boiled with 20 cc. of 10 per cent NaOH solution for one half hour, the solution cooled, and the acid precipitated by dilute HCl. It was recrystallized from 25 per cent alcohol, separating in beautiful colorless needles which melt at 193–4° C. in agreement with Tiemann.

SUMMARY

Ethyl vanillin has been oximated to the anti-oxime, which has been isomerized to the syn-form, and the latter by the action of acetic anhydride converted to 3-methoxy-4-ethoxy benzonitrile. Alkaline hydrolysis of the nitrile leads to the previously described ethyl vanillic acid, obtained by direct oxidation of ethyl vanillin.

[4] KEFFLER. Jour. Chem. Soc. 119: 148. 1921.

PALEONTOLOGY.—*New fossil fresh-water Mollusca from the Cretaceous and Paleocene of Montana.*[1] LORIS S. RUSSELL, Geological Survey, Ottawa, Canada. (Communicated by John B. Reeside, Jr.)

Dr. G. G. Simpson, of the American Museum of Natural History, recently submitted to the writer a collection of non-marine mollusks from central and southwestern Montana, material obtained under the auspices of the United States National Museum. Most of the specimens pertain to described species, but at least two new species and two varieties appear to be represented. The writer is indebted to Dr. Simpson for the opportunity of studying this collection, and to the authorities of the U. S. National Museum for permission to publish the following descriptions.

## PELECYPODA: UNIONIDAE

### Elliptio silberlingi, sp. nov.

Figs. 1 and 2.

*Type.*—U. S. National Mus. No. 75287A; paratype, No. 75287B. From the Eagle coal mine, Bear Creek, Carbon county, Montana. Upper Paleocene ("Bear Creek" horizon).

*Description.*—Shell moderately large, elongate-ovoid, flattened. Beak low, placed near anterior extremity, sculptured with two fine plications, slightly

[1] Published with the permission of the Director, Geological Survey, Department of Mines, Ottawa, Canada. Received Oct. 26, 1933.

double-looped; also a pair of fine, diverging ridges extending from posterior end of beak toward the posteroventral extremity. Anterior margin well rounded; ventral margin sinuous, convex in front, slightly concave near midlength; posterior extremity low, narrowly rounded, produced; posterior dorsal margin broadly convex. A broad, shallow sinus extending downward and somewhat backward from umbo. Surface marked by fine and coarse lines of growth. Length of holotype, 98.8 mm.; height, 44.6 mm.; thickness, as preserved, 16.3 mm.

*Remarks.*—This species clearly belongs to the group of *"Unio" priscus* and its relatives, but may be distinguished by the elongate outline and produced posterior, as well as by the reduced beak sculpture. In a forthcoming revision of the Canadian fossil Unionidae the writer erects a new subgenus for the *"Unio" priscus* group under the genus *Elliptio*. More particularly, the present species closely resembles, and probably is descended from, the Judith River form identified by Stanton[2] as *Unio subspatulatus*.

The new species is named for Mr. Albert C. Silberling, of Harlowton, Montana, in recognition of his services to paleontology.

### Medionidus? senectus (White)

*Unio senectus*, White, U. S. Geol. and Geog. Surv. Terr., Ann., Rept. for 1878, pt. 1, p. 69. *pl. 28, fig. 1, pl. 29, fig. 3.* 1883.

*Remarks.*—In his revision of Canadian fossil unionids, mentioned above, the writer tentatively refers this species to the genus *Medionidus* Simpson. This reference is based principally on the presence of postumbonal radiating sculpture. It is probable that *"Unio" senectus* represents a genus absent from the living fauna.

### Medionidus? senectus declivis, var. nov.

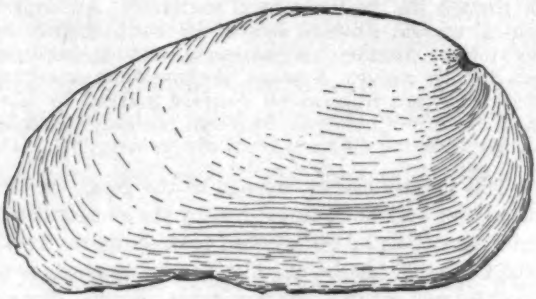
Fig. 3.

*Type.*—U. S. National Mus. No. 75288; from SE. ¼ of SE. ¼, Sec. 10, T. 5 N., R. 13 E., Sweetgrass county, Montana. Paleocene, "about 4000 feet above base of "No. 3," with highest mammals from Crazy Mountain Field, probably post-Torrejon."[3]

*Description.*—Shell elongate, tapering posteriorly; posterior dorsal margin broadly convex, sloping to the narrowly rounded posteroventral extremity. Postumbonal radiating sculpture as in *M.? senectus* but more obscure. Length of holotype, 76.4 mm., height, 41.2 mm.; thickness, as preserved, 16.8 mm.

*Remarks.*—Shells of this variety are associated at the type locality with typical examples of *M.? senectus*, from which they differ in the characters given above. Some examples from the upper Ravenscrag beds of Saskatchewan show characters intermediate between those of *M.? senectus senectus* and the present variety. The differences may be only sexual, but it is note-

[2] U. S. Geol. Surv., Bull. 257: 107. *pl. 13, fig. 1.* 1905.
[3] Simpson, personal communication.



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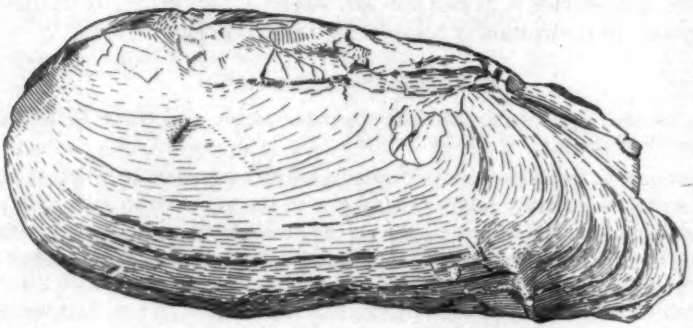

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Fig. 1.—*Elliptio silberlingi*, sp. nov., holotype, ×1.
Fig. 2.—*Elliptio silberlingi*, sp. nov., paratype, showing umbonal markings, ×1.
Fig. 3.—*Medionidus? senectus declivis*, var. nov., holotype, ×1.
Fig. 4.—*Campeloma vetulum pegmate*, var. nov., holotype, ×1. A, dorsal view; B, ventral view.
Fig. 5.—*Goniobasis ursarivulensis*, sp. nov., holotype, ×1. A, dorsal view; B, ventral view.

worthy that the variety *declivis* appears to be absent from the Judith River and contemporary faunas. All examples of this age seen by the writer have the short outline and the broad posterior extremity.

## GASTROPODA: VIVIPARIDAE

### Campeloma vetulum (Meek and Hayden)

*Paludina vetula*, Meek and Hayden, Acad. Nat. Sci. Philadelphia, Proc., 8: 121. 1857; *Campeloma vetula*, Meek, U. S. Geol. Surv. Terr., Rept., 9: 587. *pl. 42, figs. 14a, 14b.* 1876.

### Campeloma vetulum pegmate, var. nov.

Fig. 4.

*Type.*—U. S. National Mus. No. 75289; SW. ¼ of NW. ¼, Sec. 8, T. 6 N., R. 18 E., Wheatland county, Montana. About 75 feet above base of Judith River formation, Upper Cretaceous.

*Description.*—Shell as in *C. vetulum*, but with a narrow, distinct shelf along the posterior (apical) border of the whorls; body whorl relatively less ventricose. Length of holotype (first whorl missing), 20.1 mm.; width, 11.9 mm.; length of aperture, 9.7 mm.

*Remarks.*—This variety occurs associated with *C. vetulum vetulum* in the Pale beds (upper Belly River) of Alberta.

## MELANIIDAE

### Goniobasis ursarivulensis, sp. nov.

Fig. 5.

*Type.*—U. S. National Mus. No. 75290; from the Eagle coal mine, Bear Creek, Carbon county, Montana. Upper Paleocene ("Bear Creek" horizon).

*Description.*—Shell of moderate size, elongate-conoid. Spire tapering, length almost two-thirds that of shell; volutions about five, prominently convex; suture linear, broadly impressed. Inner lip of aperture nearly straight, outer lip strongly convex. Surface marked by numerous fine and a few coarse lines of growth, and occasionally by obscure revolving markings. Length of holotype, 17.8 mm.; width, 9.0 mm.; length of aperture, as preserved, 6.7 mm.

*Remarks.*—This species closely resembles, and probably is descended from, *G. sanctamariensis* Russell[4] from the St. Mary River formation of Alberta. The present species may be distinguished by the more slender shell, and the lesser prominence of the whorls, which do not show numerous fine, revolving lines. The distinction between these two species may be of value in differentiating Upper Cretaceous from Paleocene strata.

[4] Canadian Field-Nat. 46: 81. *fig. 4.* 1932.

ZOOLOGY.—*New genera and species of blood flukes from a marine turtle, with a key to the genera of the family Spirorchidae.*[1] EMMETT W. PRICE, Bureau of Animal Industry. (Communicated by BENJAMIN SCHWARTZ.)

Among some trematodes collected by Dr. B. G. Chitwood and the writer from a marine turtle, *Chelone mydas*, which died in the National Zoological Park, March 8, 1932, were a number of specimens belonging to the Spirorchidae, a family proposed by Stunkard (1921) for trematodes occurring in the circulatory system of turtles. These specimens were collected for the most part from washings of the digestive tract, but in view of their affinities with species which have been described from the blood vessels of other cold-blooded hosts, it appears certain that they had escaped from the blood vessels during evisceration; a few specimens were collected also from washings of the body cavities. These specimens were found to represent four new species and three new genera, the descriptions of which are given in this paper. In order to differentiate the new genera from related genera, a key to the genera of the family Spirorchidae is appended.

### Neospirorchis, new genus

*Generic diagnosis.*—Spirorchidae: Body greatly elongated, threadlike, subcylindrical. Cuticula provided with fine transverse ridges but without spines. Oral sucker moderately developed; acetabulum absent. Esophagus, especially the posterior half, surrounded by unicellular glands; intestinal tract similar to that of schistosomes. Genital aperture lateral, in posterior half of body. Testis slender, more or less spiral, extending to intestinal union; vas deferens arising from posterior pole of testis; cirrus pouch present. Ovary slender, spiral, situated along posterior portion of testis. Seminal receptacle and Laurer's canal absent. Vitellaria extending from intestinal bifurcation to near level of genital aperture. Eggs without polar processes. Parasitic in marine turtles.

*Type species.*—*Neospirorchis schistosomatoides*, new species.

### Neospirorchis schistosomatoides, new species

Figs. 1–2.

*Description.*—*Neospirorchis:* Body threadlike, 7.45 to 9.5 mm. long by about 140 to 220$\mu$ wide; pretesticular portion of body slightly flattened dorsoventrally, posttesticular portion cylindrical or subcylindrical. Cuticula without spines but marked with fine transverse ridges. Oral sucker subterminal, 32 to 40$\mu$ in diameter; acetabulum absent. Esophagus 595 to 680$\mu$ long, consisting of two parts about equal in length; anterior part slender, posterior part about twice the width of anterior part and surrounded by unicellular glands. Intestinal branches slightly sinuous, uniting near level of

[1] Received November 18, 1933.

anterior pole of testis, forming a common cecum terminating near posterior end of body. Excretory pore terminal; excretory vesicle Y-shaped. Genital aperture lateral, about 1 to 1.2 mm. from posterior end of body. Cirrus pouch weakly developed, enclosing a long, slender, muscular cirrus; cirrus apparently protrusible, but not actually protruded in any of the specimens available. Vas deferens relatively long and convoluted, arising from posterior pole of testis. Testis long, slender, more or less spiral, and extending anteriorly as far as level of intestinal union. Ovary long, slender, more or less spiral, and extending anteriorly from a point posterior to genital aperture for about one-third the length of testis. Oviduct slender, extending posteriorly to an ootype about 500$\mu$ from posterior end of body; oviduct joined here by vitelline duct and continued anteriorly as a slender tube expanding to form the uterus. Seminal receptacle and Laurer's canal absent. Vitellaria well developed, extending in intercecal field from posterior end of esophagus to intestinal union, thence continuing dorsal to common cecum and terminating near level of genital aperture. Vitelline duct single, extending posteriorly to ootype and expanding there to form a large vitelline reservoir. Uterus slightly tortuous, containing 7 to 15 eggs, extending anterior to genital aperture, then turning posteriorly. Eggs oval, 44$\mu$ long by 32$\mu$ wide, without polar prolongations.

*Host.—Chelone mydas.*

*Location.*—Visceral blood vessels.

*Locality.*—United States (Washington, D. C.).

*Type specimen.*—U. S. N. M. Helm. Coll. No. 32563; paratypes No. 32564.

*Neospirorchis schistosomatoides* appears to be more or less closely related to *Unicaecum ruszkowskii*, a species described by Stunkard (1925, 1927) from *Pseudemys scripta*, but differs from that species in the form of the digestive tract and in the point of origin of the vas deferens. In *N. schistosomatoides* the digestive tract is of the same type as that found in members of the family Schistosomatidae, while in *U. ruszkowskii* the digestive tract consists of a single cecum. The vas deferens in *N. schistosomatoides* arises from the posterior pole of the testis, while in *U. ruszkowskii* it arises from the anterior pole of the testis, and extends parallel to the testis for its entire length.

The form of the digestive tract in *N. schistosomatoides* is of especial interest, since this is the first species of blood fluke from cold-blooded vertebrates which has a digestive system of the type characteristic for blood flukes occurring in warm-blooded vertebrates. A tendency toward fusion of the intestinal ceca to form a digestive tract of the schistosome type has been reported by Stunkard (1923) in specimens of *Spirorchis*.

### Amphiorchis, new genus

*Generic diagnosis.*—Spirorchidae: Body slender, subcylindrical. Cuticula marked with fine transverse ridges. Oral sucker and acetabulum present. Esophagus slender, surrounded by unicellular glands; intestinal ceca slender, not uniting posteriorly. Cirrus pouch well developed, containing a short cirrus, internal seminal vesicle and prostate cells; external seminal vesicle anterior to cirrus pouch. Testes two in number, one anterior and the other posterior to cirrus pouch and ovary. Seminal receptacle and Laurer's canal

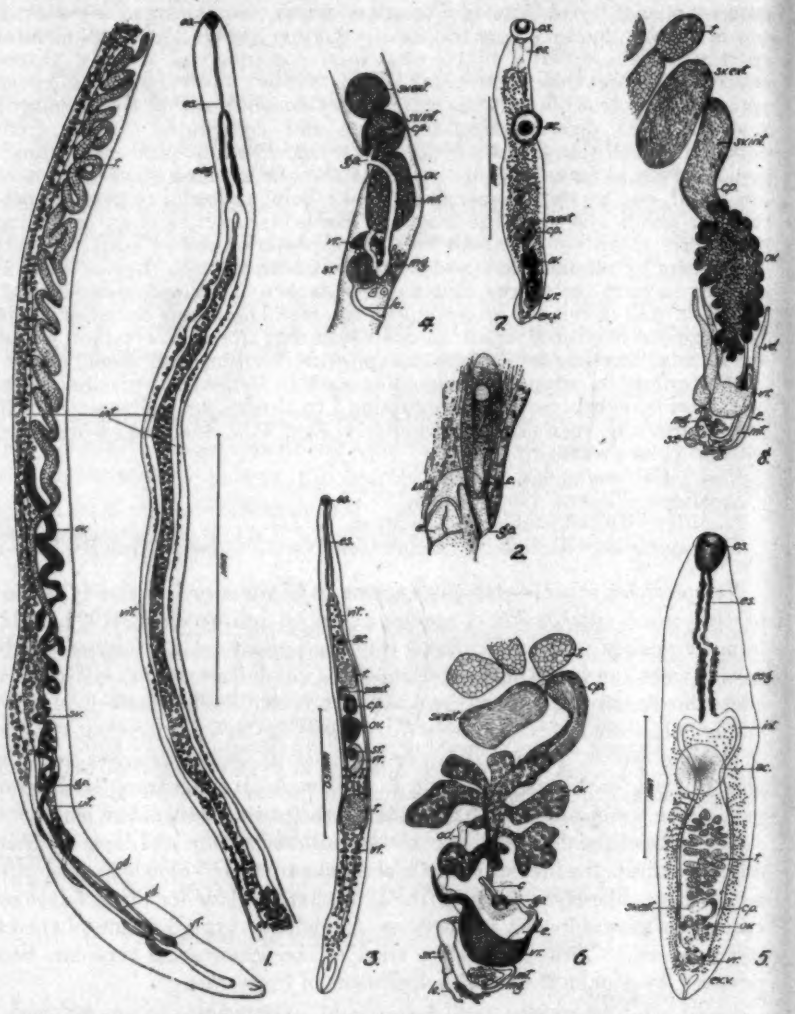

Fig. 1. *Neospirorchis schistosomatoides*. Entire worm. Fig. 2. *N. schistosomatoides*. Terminal portions of genital system. Fig. 3. *Amphiorchis amphiorchis*. Entire worm; ventral view. Fig. 4. *A. amphiorchis*. Genital complex; reconstructed from serial sections. Fig. 5. *Learedius learedi*. Entire worm; ventral view. Fig. 6. *L. learedi*. Genital complex; greatly enlarged. Fig. 7. *L. similis*. Entire worm; ventral view. Fig. 8. *L. similis*. Genital complex; greatly enlarged.

| | | | |
|---|---|---|---|
| *ac.* | Acetabulum | *mg.* | Mehlis' gland |
| *c.* | Cirrus | *mt.* | Metraterm |
| *cp.* | Cirrus pouch | *od.* | Oviduct |
| *e.* | Egg | *ov.* | Ovary |
| *es.* | Esophagus | *sr.* | Seminal receptacle |
| *esg.* | Esophageal glands | *sv. ext.* | External seminal vesicle |
| *ex. v.* | Excretory vesicle | *sv. int.* | Internal eminal vesicle |
| *gp.* | Genital aperture | *t.* | Testis |
| *int.* | Intestine | *vit.* | Vitellaria |
| *lc.* | Laurer's canal | *vr.* | Vitelline reservoir |

present. Vitellaria consisting of two groups of follicles, one group extending from intestinal bifurcation to anterior testis, and the other from posterior end of vitelline reservoir to near posterior end of body. Parasitic in blood vessels of marine turtles.

*Type species.*—*Amphiorchis amphiorchis*, new species.

### Amphiorchis amphiorchis, new species

Figs. 3–4.

*Description.*—*Amphiorchis:* Body elongated, 1.87 to 2.2 mm. long by 120 to 148$\mu$ wide at level of posterior testis, oval to subcylindrical on cross section. Cuticula without spines but marked by fine transverse striations. Oral sucker subterminal, 40 to 44$\mu$ in diameter; acetabulum circular, 40 to 64$\mu$ in diameter, 476 to 510$\mu$ from anterior end of body. Esophagus 255 to 320$\mu$ long, surrounded by unicellular glands; intestinal ceca slender, terminating blindly about 280$\mu$ from posterior end of body. Excretory pore terminal; excretory vesicle Y-shaped, the branches slightly longer than the stem. Genital aperture median, immediately anterior to ovary. Cirrus pouch oval, 60 to 80$\mu$ long by 48 to 60$\mu$ wide, enclosing a short, thick cirrus, a moderately large internal seminal vesicle, and numerous prostate cells; external seminal vesicle more or less globular, 40 to 60$\mu$ in diameter, immediately anterior to and slightly to right of cirrus pouch. Anterior testis oval, 100 to 120$\mu$ long by 80 to 88$\mu$ wide, in front of external seminal vesicle; posterior testis oval, 140 to 190$\mu$ long by 100 to 120$\mu$ wide, situated a short distance caudal to posterior end of vitelline reservoir and separated from it by a band of vitelline follicles. Ovary irregularly oval, 120 to 140$\mu$ long by 54 to 80$\mu$ wide, between testes and immediately posterior to cirrus pouch. Seminal vesicle globular, 24 to 40$\mu$ in diameter, posterior to ovary and situated in curve of vitelline reservoir. Mehlis' gland present, consisting of relatively few large cells; Laurer's canal relatively large, opening in middorsal line a short distance posterior to seminal receptacle. Vitelline reservoir large and curved; vitellaria consisting of two groups of follicles, one group between intestinal bifurcation and anterior testis and the other between posterior end of vitelline reservoir and posterior end of body. Metraterm simple, muscular. Eggs not observed.

*Host.*—*Chelone mydas.*

*Location.*—Visceral blood vessels.

*Locality.*—United States (Washington, D. C.).

*Type specimen.*—U. S. N. M. Helm. Coll. No. 32565, paratypes No. 32566.

The genus *Amphiorchis* appears to be more closely related to the genera *Hapalotrema* Looss, *Spirhapalum* Ejsmont, and *Hapalorhynchus* Stunkard than to any of the other genera of Spirorchidae. *Amphiorchis amphiorchis* is more slender and the testes are simple instead of being divided into preovarial and postovarial groups of follicles as is the case of the types of *Hapalotrema* and *Spirhapalum*. In body form it resembles most closely *Hapalorhynchus gracilis* Stunkard, but in that species the genital aperture is dorsal and the anterior testis is situated posterior to the genital aperture and seminal vesicle, while in *A. amphiorchis* the genital aperture is ventral and the anterior testis is anterior to the seminal vesicle.

### Learedius, new genus

*Generic diagnosis.*—Spirorchidae: Body elongate, slightly constricted equatorially, flattened dorsoventrally. Oral sucker and acetabulum present. Esophagus long and surrounded by unicellular glands; intestinal ceca slender, not uniting posteriorly. Genital aperture median or slightly to left, near posterior end of body. Cirrus pouch present, largely filled by internal seminal vesicle; external seminal vesicle present. Testes numerous, preovarial. Ovary deeply lobed, posttesticular. Laurer's canal present. Eggs with polar prolongations. Parasitic in circulatory system of marine turtles.

*Type species.*—*Learedius learedi*, new species.

### Learedius learedi, new species

Figs. 5–6.

*Description.*—*Learedius:* Body elongated, 3.4 mm. long by 690μ wide, slightly constricted near equator of body, flattened dorsoventrally. Cuticula with verrucae similar to, but smaller than, those of species of *Schistosoma*. Oral sucker cup-shaped, 280μ long by 240μ wide, oral aperture subterminal; acetabulum circular, 340μ in diameter, pedunculated, near equator of body, Esophagus slightly tortuous, 1.02 mm. long, surrounded by unicellular glands. Intestinal ceca slender, curving inward at level of acetabulum, terminating near posterior end of body. Excretory pore terminal; excretory vesicle Y-shaped, the branches of about the same length as stem. Genital aperture about 360μ from posterior end of body, slightly left of median line. Cirrus pouch shaped somewhat like an elongated letter S, its base enlarged and lying about 360μ from genital aperture, containing a slender internal seminal vesicle, numerous prostate cells, and a protrusible cirrus; external seminal vesicle transversely elongated, 144μ long by 60μ wide, to right of base of cirrus pouch. Testes 28 in number, in intercecal field between external seminal vesicle and acetabulum. Ovary deeply lobed, more or less dendritric, 240μ long by 240μ wide, posterior to external seminal vesicle. Oviduct long and slender, arising at right side of ovary and expanding posteriorly to form an elongated ootype; seminal receptacle postero-dorsal of ootype; Laurer's canal slender, opening in mid-dorsal line near level of ends of ceca. Vitelline reservoir large, anterior to ootype. Vitellaria consisting of small follicles forming a transverse band across body between intestinal bifurcation and level of posterior margin of acetabulum, then extending posteriorly in extracecal fields to level of tips of ceca. Metraterm short and containing a single egg. Egg fusiform, about 210μ long (including polar prolongations) by 28μ wide.

*Host.*—*Chelone mydas.*

*Location.*—Circulatory system.

*Locality.*—United States (Washington, D. C.).

*Type specimen.*—U. S. N. M. Helm. Coll. No. 32567.

### Learedius similis, new species

Figs. 7–8.

*Description.*—*Learedius:* Body elongated, 2.2 mm. long by 320μ wide, slightly constricted at level of acetabulum. Cuticula with verrucae larger and less numerous than those of *L. learedi*. Oral sucker subterminal, 160μ in diameter; acetabulum circular, 240μ in diameter, pedunculated, about

750μ from anterior end of body. Esophagus about 170μ long, surrounded by unicellular glands; intestinal ceca slender, extending to near posterior end of body. Excretory pore terminal; excretory vesicle Y-shaped, the limbs longer than stem. Genital aperture almost median, 260μ from posterior end of body. Cirrus pouch somewhat S-shaped, its base about 1 mm. from genital aperture, almost completely filled by internal seminal vesicle; external seminal vesicle 180μ long by 80μ wide, situated as in *L. learedi*. Testes arranged as in *L. learedi*, the exact number not ascertainable in the specimen available. Ovary lobulated, 260μ long by 120μ wide, between external seminal vesicle and vitelline reservoir, ventral to cirrus pouch. Oviduct dilated, arising from right side of ovary; ootype short and surrounded by Mehlis' gland; seminal receptacle present; Laurer's canal not observed. Vitellaria extending from level of intestinal bifurcation to about middle of ovary and occupying entire intercecal field anterior to testes. Egg fusiform, 234μ long (including polar prolongations) by about 12μ wide.

*Host.*—*Chelone mydas.*
*Location.*—Circulatory system.
*Locality.*—United States (Washington, D. C.).
*Type specimen.*—U. S. N. M. Helm. Coll. No. 32568.

The descriptions of *Learedius learedi* and *L. similis* are each based upon a single specimen, but in view of certain distinct differences they cannot be regarded as the same species. These differences are as follows: *L. similis* has a much shorter esophagus and the intestinal bifurcation occurs much farther cephalad of the acetabulum than in *L. learedi;* the testes are much less numerous than in *L. learedi;* the cirrus pouch is relatively much longer and encloses a larger internal seminal vesicle and fewer prostate cells than does that of *L. learedi;* the ovary, while distinctly lobed, does not present the dendritic appearance of that structure in *L. learedi;* and the vitellaria in *L. similis* extend posteriorly only as far as the level of the middle of the ovary, while in *L. learedi* they extend to the level of the tips of the ceca. The egg is also somewhat different in the two species, that of *L. similis* being longer and more slender than that of *L. learedi.*

In addition to the two species just described, *Distoma constrictum* Leared must also be included in the genus *Learedius.* This species was described by Leared (1862) from the "edible turtle" (also referred to in the same paper as the "common turtle"), the specimens having been collected from the heart, and submitted to Cobbold who regarded them as larval flukes. Almost no description was given for this species aside from the size—"Their average length was a line and a half, and the breadth about one third of this,"—and a few minor comments on the shape of the body and on the configuration of the digestive tract. Judging from the figure accompanying the description, the species is closely related to *Learedius learedi* described in this paper and may actually be the same. However, the writer feels that the two forms should be regarded as distinct until such time as a restudy can be made of specimens from the same host and from the same locality as that from which Leared's specimens were obtained. The apparent points of difference be-

tween the two forms are the longer and more serpentine esophagus and the smaller number of testes in Leared's species as compared with these structures in *L. learedi*.

In reviewing the literature concerning *Distoma constrictum* Leared, a situation was discovered which involves the validity of the name of Leared's species as well as of the status of forms subsequently described by Monticelli (1896) and by Looss (1899), which were regarded by them as the same as *D. constrictum* Leared. This situation is briefly summarized as follows:

*Distoma constrictum* Leared, 1862, is preoccupied by *D. constrictum* Mehlis, in Creplin, 1846, making Leared's *constrictum* a homonym and, consequently, unavailable. This fact was noted by Monticelli (1896) who described under the name of *Mesogonimus constrictus* (Leared) a blood fluke from "*Thalassochelys caretta* Linn." Despite the fact that he noted the priority of names he continued to use the specific name *constrictus* throughout the paper. In his discussion, however, he stated: "Per questo suo caratteristico aspetto, qualora avesse dovuto cambiar nome specifico, il distomide del Leared avrebbe potuto meritar quello *mistroides* (da *μιστροσ-ον* cucchiaio)." This statement was regarded by Stiles and Hassall (1908) as a renaming of *Distoma constrictum* Leared. Later Looss (1899) proposed the genus *Hapalotrema* for *Mesogonimus constrictus* (Leared) of Monticelli, basing his discussion of this form on material collected by him from the heart of "*Thalassochelys corticata*" at Abukir, Egypt. A comparison of the descriptions and figures given by Monticelli and by Looss, however, show certain differences which suggest that while the forms studied by them are unquestionably congeneric, they probably represent distinct species, and are not the same as, or congeneric with, the species described by Leared. In view of the foregoing, the following points must be considered: (1) The status of *D. constrictum* Leared and of the name *mistroides* Monticelli; (2) the status of the genus *Hapalotrema* Looss; and (3) the identity of *Mesogonimus constrictus* (Leared) of Monticelli and *Hapalotrema constrictum* (Leared) of Looss. The solution of these problems appears to the writer to be as follows:

1. Since *Distoma constrictum* Leared is a homonym it must be renamed, and since the name *mistroides* indicates an anatomical character (spoon-like shape of the body) of the species which Monticelli described as *Mesogonimus constrictus* and which does not apply to Leared's species, the specific name *mistroides* must apply to Monticelli's species. The writer, therefore, proposes for *D. constrictum* Leared the new name *Learedius europaeus*.

2. *Hapalotrema* Looss was proposed as a genus for *Mesogonimus constrictus* (Leared) of Monticelli and applies to that species and not to Leared's species, and since the specific name *mistroides* appears to be the valid name for Monticelli's form, the type of the genus is *Hapalotrema mistroides* (Monticelli, 1896) Stiles and Hassall, 1908 (syn. *Mesogonimus constrictus* (Leared) of Monticelli, 1896; misdetermination).

3. Neither Monticelli nor Looss gave any indication as to the extent of variation occurring in the specimens which they studied, and in view of this

lack of information one must assume that the drawings which they published are representative of the forms which they had before them. A comparison of these drawings shows differences in the number of testes and in the extent of vitellaria, and in body proportions which are as great as, or greater than, those occurring in species of other genera. Monticelli's figure shows 9 testes in the preovarial group and 16 in the postovarial group, whereas in Looss' figure there are 8 in the preovarial group and only 10 in the postovarial group. Monticelli's figure also shows distinctly that the vitellaria unite in the median field anterior to the preovarial group of testes and also posterior to the postovarial group, while in Looss' figure no such union is shown. In Monticelli's figure the oral sucker is of the same size as the acetabulum, while in Looss' figure the oral sucker is about one-third smaller than the acetabulum. There are also noticeable differences in the relative distances between the suckers in the two illustrations, but these may be due to variation in the amount of contraction or extension of the specimens drawn. In view of the disparity as given above the writer feels that for the time being Looss' form should be regarded as a distinct species and proposes for it the name *Hapalotrema loossi* (syn. *Hapalotrema constrictum* (Leared) of Looss, 1899, not *H. constrictum* (Leared) of Monticelli = *H. mistroides* (Monticelli).

Up to the present time the following genera have been included in the family Spirorchidae: *Spirorchis* MacCallum, 1918 (syn. *Proparorchis* Ward, 1921), *Henotosoma* Stunkard, 1922; *Haematotrema* Stunkard, 1922; *Hapalotrema* Looss, 1899; *Hapalorhynchus* Stunkard, 1922; *Vasotrema* Stunkard, 1926; *Unicaecum* Stunkard, 1926; *Spirhapalum* Ejsmont, 1927; *Diarmoschistorchis* Ejsmont, 1927; and *Tremarhynchus* Thapar, 1933. To this family are now added three additional genera, *Neospirorchis* n. g., *Amphiorchis* n. g., and *Learedius* n. g. Whether all of these genera should be regarded as valid is a matter of personal opinion. Ejsmont (1927) not only doubts the validity of some species assigned to certain of the above genera but of some of the genera as well. The present writer does not propose to go into the question of the validity of the species at the present time, but so far as the genera are concerned he does not regard *Henotosoma* Stunkard and *Haematotrema* Stunkard as sufficiently different from the genus *Spirorchis* to be considered distinct, the types of the genera, *Henotosoma haematobium* Stunkard and *Haematotrema parvum* Stunkard, becoming *Spirorchis haematobium*, (Stunkard) and *S. parvum* (Stunkard), respectively. *Tremarhynchus indicus*, as described by Thapar (1933), apparently does not differ sufficiently from *Hapalorhynchus gracilis* Stunkard to warrant its separation as a distinct genus, the differences being specific rather than generic; *T. indicus* Thapar, therefore, becomes *H. indicus* (Thapar).

The genera of Spirorchidae fall into two more or less well defined groups, one consisting of monostomatous forms and the other of distomatous forms. Ejsmont, however, has shown that evidence of transition occurs in some of the genera, a fact which makes it undesirable to regard the two groups as

subfamilies. In the genus *Diarmoschistorchis*, which was proposed for a monostomatous species, *Spirorchis blandingi* MacCallum (1926), the testes are arranged in two groups, one group preovarial and the other postovarial; this condition simulates that occurring in species of *Hapalotrema*, which are distomatous. The writer has had the opportunity of examining MacCallum's specimens of this species, and is inclined to regard it as an abberrant form not closely related to the distomatous species. The testes, 12 or 13 of which are preovarial and 3 postovarial, are arranged in a linear series as in the monostomatous species and not irregularly as in the distomatous species; the arrangement of the other organs is the same as in the genus *Spirorchis*. The relation of *Diarmoschistorchis blandingi*, therefore, to such genera as *Haplorchis*, *Amphiorchis*, and others of the distomatous group is questionable. The other example of transition between the two groups, which Ejsmont pointed out, is *Spirhapalum polesianum;* this is a distomatous form which does show definite evidence of transition, especially as regards the egg which is oval and contains a miracidium with eyespots as in the genus *Spirorchis*. Aside from the egg, *S. polesianum* might easily be regarded as congeneric with *Hapalotrema mistroides*, but in the latter species the egg is spindle-shaped and the miracidium is not provided with eyespots. Much might be said regarding the relationships of the genera and families of blood flukes, but such a discussion is not within the scope of this paper.

### KEY TO THE GENERA OF THE FAMILY SPIRORCHIDAE

1. Monostomatous forms ..... 2
   Distomatous forms ..... 5
2. Testes 2 or more ..... 3
   Testis single and spiral ..... 4
3. Testes preovarial ..... *Spirorchis*
   Testes both preovarial and postovarial ..... *Diarmoschistorchis*
4. Intestine consisting of a single cecum ..... *Unicaecum*
   Intestine consisting of 2 branches uniting near equator of body and forming a common cecum as in the Schistosomatidae ..... *Neospirorchis*
5. Testes numerous, preovarial ..... *Learedius*
   Testes numerous, or single, both preovarial and postovarial, or postovarial only ..... 6
6. Testis single, postovarial; esophageal diverticula present ..... *Vasotrema*
   Testes 2 or more, preovarial and postovarial; esophageal diverticula absent ..... 7
7. Testes numerous ..... 8
   Testes 2 in number ..... 9
8. Egg oval; miracidium with eyespots ..... *Spirhapalum*
   Egg spindle-shaped; miracidium without eyespots ..... *Hapalotrema*
9. Genital aperture dorsal, in front of anterior testis ..... *Hapalorhynchus*
   Genital aperture ventral, posterior to anterior testis ..... *Amphiorchis*

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## ZOOLOGY.—*A new species of the nematode genus* Aphelenchoides *living in sugar cane.*[1]

G. STEINER, Bureau of Plant Industry.

*Aphelenchoides heterophallus* n. sp. was observed in a piece of sugar cane stalk originating in Jamaica.[2] The rind of the cane was a normal green color; the axial portion, however, had a blackish discoloration probably caused by a fungus. It was in this latter portion that a pure culture of the new nematode species was found. *A. heterophallus* is a well characterized form, most closely related to certain species found in the mines of and associated with bark beetles of Europe and the Pacific Northwest. The present case may also involve some association with an insect (most probably a carrier relationship), although the piece of sugar cane stalk exhibited neither mines nor other traces of insects. The complete absence of saprophytic nematode species and of signs of decay seems to exclude the possibility that the infestation was picked up by contact with soil.

The thin cuticle is very obscurely annulated. The anteriorly convex head is well set off. Male and female tails differ in shape, that of the latter being conical and elongated (fig. 1B), and that of the former having a broad, obtuse base with a distinctly set off point (fig. 1D and E). The length of the female tail, however, is quite variable. The head is supported by a cuticu-

[1] Received December 19, 1933.

[2] Intercepted at the Port of Philadelphia, Pa. by inspector A. B. Wells of the Bureau of Plant Quarantine.

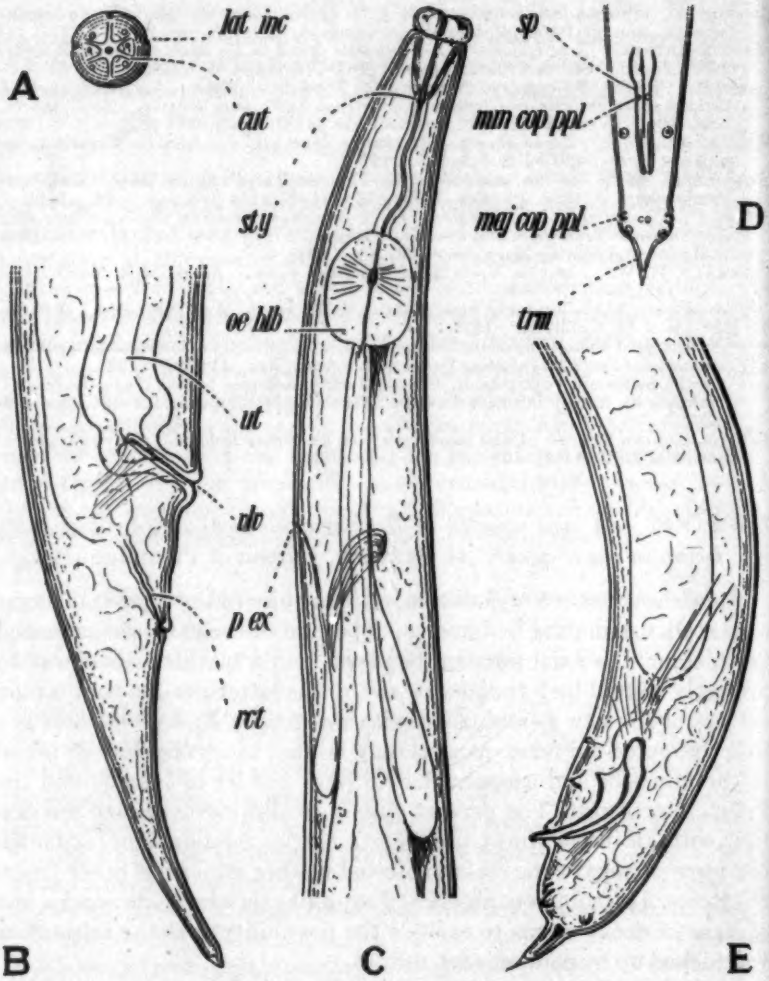


Fig. 1.—*Aphelenchoides heterophallus* n. sp. × about 1250. A, Top view of head: *lat inc*, lateral incisure; *cut*, cuticularized framework. B, Posterior portion of female; *ut*, uterus; *vlv*, vulva; *rct*, rectum. C, Anterior portion of body; *sty*, buccal stylet; *oe blb*, esophageal bulb; *p. ex*, excretary pore. D, Ventral view of tail of male; *sp*, spicula; *min cop ppl*, small copulatory papilla; *maj cop ppl*, large copulatory papilla; *trm*, terminal processus. E, Lateral view of tail of male.

larized framework which is star-shaped in front view (fig. 1A). The arrangement of the sense organs is that typical for the genus. In a front view of the head a rather remarkable lateral and medial incisure is seen on the periphery. The delicate buccal stylet has only a slight indication of basal knobs. The very large esophageal bulb, located about three spear-lengths behind the anterior end, is provided with small valvulae and rather reduced muscles. The rectum is about as long as the anal body diameter. Males and females are equally numerous.

The most characteristic feature of the female is the prominent vulva located near the anus (fig. 1B), the distance between vulva and anus being only about half the length of the tail. The single ovary is not reflexed. There is no posterior uterine branch.

In the male the terminal processus also varies somewhat in size and shape. The spicula are juxtaposed (fig. 1E) and of quite characteristic shape, though they still retain the outlines of typical *Aphelenchoides* spicula. There are two small and three large pairs of copulatory papillae (fig. 1D and E). The smaller ones are close to the ventromedial line, one pair being about level with the proximal third of the spicula in front of the anus, the other in about the middle of the tail. Of the three larger pairs the first is located a little caudad of the middle of the spicula, the second ventro, the third dorsosubmedial, close to the base of the obtuse portion of the tail.

| | | med. bulb | nrv. ring | | | |
|---|---|---|---|---|---|---|
| | | | | 70. | | |
| female— | 1.0 | 5.2 | 6.1 | 92.6 | 95.7 | 0.75 mm. |
| | .97 | 1.7 | 1.7 | 2.2 | 1.3 | |
| | | | | 74. | | |
| male— | 1.3 | 6.3 | 7.1 | M | 97.5 | 0.71 mm. |
| | 1.1 | 2.2 | 2.2 | 2.9 | 1.6 | |

DIAGNOSIS

*Aphelenchoides* with delicate, minutely knobbed stylet. Vulva prominent; distance from vulva to anus about one-half the length of tail or less. Male tail with broad, obtuse basal portion ending with a distinctly set-off finger-like processus. Male papillae as follows: A pair of small papillae subventral about level with the proximal third of the spicula; a similar pair also subventral in the middle of the tail; a pair of larger ones, ventrosubmedial, slightly caudad of the middle of the spicula; a second and third larger pair ventrosubmedial and dorsosubmedial respectively, at the base of the obtuse portion of the tail. Spicula juxtaposed, aphelenchoid.

*Type host:* Sugar cane.

*Type locality:* Jamaica.

# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## THE ACADEMY

### 255TH MEETING

The 255th meeting of the Academy was held in the Auditorium of the National Museum at 4:45 P.M., on Thursday, November 16, 1933. About 150 persons were present. President GRIGGS introduced the Reverend Dr. G. LEMAITRE, professor of physics in the University of Louvain and lecturer at the Catholic University of America, who delivered an address on *The expanding universe.*

### 256TH MEETING

The 256th meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club on Thursday, January 18, 1934. Seventy five persons were present. Vice President H. L. CURTIS presided and introduced ROBERT F. GRIGGS, Professor of Botany, George Washington University, retiring President of the ACADEMY, who delivered an address on *The problems of Arctic vegetation.*

The 36th Annual Meeting of the ACADEMY was called to order by President R. F. GRIGGS, at 9:20 P.M., immediately after the 256th regular meeting. Thirty-six members were present. The minutes of the 35th Annual Meeting were read by the Recording Secretary and approved.

Annual reports of officers were presented as follows:

The corresponding secretary reported that on January 1, 1934, the membership consisted of 16 honorary members, 3 patrons, and 521 members, one of whom was a life member. The total membership was 540 members, of whom 378 reside in or near the District of Columbia, 136 in other parts of the continental United States, and 26 in foreign countries.

The members of the ACADEMY stood while the Secretary announced the following deaths:

| | |
|---|---|
| OTIS F. BLACK | F. P. GORHAM |
| ARTHUR P. DAVIS | W. H. HOLMES |
| HARLAN W. FISK | ORMOND STONE |

The Recording Secretary summarized the five public meetings of the ACADEMY, one of which was a joint meeting with the Medical Society.

The Treasurer reported that the receipts of the ACADEMY during the past year amounted to $4,983.81 including the return of investment of $50 and interest on investments of $993.06. The disbursements amounted to $5,195.30 including bills for the year 1932 totaling $413.79. The bank balance at the end of the year was $1,365.35. The investments of the ACADEMY comprise $6,337.50 in stocks, $6,758.87 in bonds, and $8,000.00 in real estate notes making a total of $21,096.37 computed on the basis of cost to the ACADEMY.

Doctor H. H. HARLAN, chairman of the board of auditors, reported examination and approval of the books and properties in the hands of the Treasurer, after which both reports were accepted.

The report of the Board of Editors was presented by the Senior Editor, HUGH L. DRYDEN. Volume 23 consisted of 77 original papers covering 588 pages and illustrated by 30 halftones and 78 line cuts. The total cost per printed page exclusive of reprints and of the cost of the new's service was

$5.50 as compared with $6.62 for 1932. The cost to the ACADEMY of supplying 50 free reprints of each article was $0.57 per page. A marked increase in the space devoted to scientific notes and news was made possible by a contract with Science Service operative during the year.

Doctor W. B. Bell, chairman of the board of tellers, reported the election of the following officers: *President*, L. B. TUCKERMAN; *non-resident Vice-Presidents*, E. C. ANDREWS and E. T. WHERRY; *Corresponding Secretary*, PAUL E. HOWE; *Recording Secretary*, CHARLES THOM; *Treasurer*, H. G. AVERS; *Managers for the term of three years ending January, 1937*, W. M. CORSE and J. E. GRAF.

The Corresponding Secretary read the list of members nominated for Vice-Presidents by the affiliated societies. Upon motion the entire list was unanimously elected as follows:

Philosophical Society, H. L. DRYDEN
Anthropological Society, MATTHEW W. STIRLING
Biological Society, CHAS. E. CHAMBLISS
Chemical Society, D. BREESE JONES
Entomological Society, HAROLD MORRISON
Geographic Society, FREDERICK V. COVILLE
Geological Society, C. N. FENNER
Medical Society, H. C. MACATEE
Historical Society, A. C. ALLEN
Botanical Society, CHARLOTTE ELLIOTT
Archaeological Society, WALTER HOUGH
Society of Foresters, SAMUEL B. DETWILER
Washington Engineers, PAUL C. WHITNEY
Electrical Engineers, E. C. CRITTENDEN
Mechanical Engineers, H. L. WHITTEMORE
Helminthological Society, G. STEINER
Bacteriological Society, N. R. SMITH
Military Engineers, C. H. BIRDSEYE
Radio Engineers, H. G. DORSEY.

President GRIGGS appointed Past President L. H. ADAMS to escort President TUCKERMAN to the chair. After a short address, he declared the meeting adjourned.

CHARLES THOM, *Recording Secretary.*

## BOTANICAL SOCIETY

### 246TH MEETING

The 246th regular meeting was held in the Assembly Hall of the Cosmos Club on January 3, 1933. President CHARLES BROOKS presided; attendance 150.

*Brief notes and reviews:* A. S. HITCHCOCK of the International Committee on Botanical Nomenclature reported that the new rules were practically finished in English and that translation into other languages would probably be completed by the end of 1933.

*Program:* W. A. ARCHER: *Botanical explorations in Choco Province, Colombia.*—Choco Province is about twice the size of New Hampshire with a low central area surrounded on all sides by mountains. The annual rainfall is approximately 457 inches. The population of some 60,000 consists of a few

scattered white people and the balance Indians of Choco stock and negroes. About 500 plant specimens were secured, including a large number of new species. Of the scant 40 economic plants obtained, several are new, indicating the need for further studies of the flora of the region.

### 247TH MEETING

The 247th meeting was held in the Assembly Hall of the Cosmos Club, February 7, 1933. President CHARLES BROOKS presided; attendance 55. FLORENCE E. MEIER and LEWIS B. LOCKWOOD were elected to membership.

*Brief notes and reviews:* W. A. WHITNEY reviewed a new *Dictionary of Colors* by Maerz and Paul, including more than 7,000 colors, which may be freely exposed to the light. DAVID GRIFFITHS exhibited a plant of the genus *Lachenalia* with decorative leaves and flowers. M. B. WAITE reported on two interesting conifers, *Torrya taxifolia* and *Juniperus barbadensis*, the latter growing at Wrightsville, North Carolina, 30 miles north of its previous northernmost station. H. R. FULTON exhibited a branch of satsuma orange bearing fruiting bodies of *Schizophyllum commune*.

*Program:* CHARLES THOM: *The arsenic fungi.*—The history and significance of the group of fungi capable of attacking insoluble arsenical substances and producing gases with a garlic odor and more or less toxicity, were developed along the lines established by Thom and Raper in Science 76 (1980): 548–550, December 9, 1932. The ubiquity of these species in relation to the general use of arsenic in excess in combatting insects was stressed as involving injury to certain crops and health hazards worthy of serious consideration. (*Author's abstract.*)

Discussed by Messers WHITNEY, WAITE, RAPER, THONE, and ROSE.

G. M. DARROW: *Short daily light periods the cause of the rest period and regional adaptation in strawberries.*—This was a report of experiments and observations covering the past ten years on the effect on varieties and species of short days during summer, and long days during winter, the relation of shortening days of fall to the rest period, the intensity of the rest period of different varieties, breaking the rest period by exposure to low temperatures and by increasing the daily light period, and the significance of this in breeding. (*Author's abstract.*)

### 248TH MEETING

The 248th meeting was held at Meridian Mansions Hotel, March 7, 1933. President CHARLES BROOKS presided, attendance 89.

Dinner was served at 7:00 o'clock. DAVID GRIFFITHS supplied extensive table decorations including Narcissus, Iris, and Lachenalia. During the meeting he pointed out the different varieties and explained a new method of forcing which had enabled him to secure the blooms within three to four weeks. DEAN H. ROSE outlined briefly various methods of preparing frozen fruits, of which the strawberries served at the dinner were an example.

*Program:* J. R. SWALLEN: *Yucatan as seen by a botanist.*

### 249TH MEETING

The 249th meeting was held in the Assembly Hall of the Cosmos Club, April 4, 1933, President CHARLES BROOKS presiding; attendance 109. JAMES M. PICKENS was elected to membership.

*Brief notes and reviews:* F. THONE exhibited four recently published botanical works, *Plant Sociology*, Braun-Blanquet; *Plant Ecology*, Weaver

and Clements; *Natural Gardens of North Carolina*, Wells; and *The Plant World in Florida*, Nehrling. C. A. LUDWIG showed graphs of the distribution of cowpea and hairy vetch seeds by weight classes. R. KENT BEATTIE called attention to the first two numbers of *Phytopathological Classics*, the first *Attempt at a dissertation on the diseases of plants* by Fabricus, published in 1774 and translated by Mrs. K. Ravn; and the second, *Observations on the rust of grains* by Fontana, published in 1767. H. B. HUMPHREY discussed the precipitation record for Washington, D. C., from January 1930 through March 1933, the record disclosing a net accumulated deficiency of 23.53 inches.

*Program:* D. H. ROSE: *Bruising and freezing injury of apples in storage and transit.*—Published in mimeographed form by the Bureau of Plant Industry.

CHARLES DRECHSLER: *The capturing of nematodes by fungi.*—Published in substance. THIS JOURNAL **23**: 138–141. 1933.

### 250TH MEETING

The 250th meeting was held in the Assembly Hall of the Cosmos Club, May 2, 1933, President CHARLES BROOKS presiding; attendance 44.

*Brief notes and reviews:* H. B. HUMPHREY exhibited 9 species of endemic violets. C. A. LUDWIG exhibited a specimen of quack grass (*Agropyron repens*) which had grown through the root of a sumac bush. A. S. HITCHCOCK requested information on the location of types of plants to be used in a central index of types which would be available to botanists.

*Program:* J. H. MARTIN: *Grohoma and other fake grains: their origin and exploitation.*—Grain crops are a favorite medium for exploiters. Poulard, Polish, Fulcaster and other wheats, hulless varieties of oats and barley, proso and Pearl millets have been exploited frequently. Grohoma, a new grain sorghum, has been exploited by several firms and individuals since 1929. It was claimed to have been originated by grafting a kafir bud on a stalk of sorgo. Extravagant and fraudulent claims were made for Grohoma in extensive seed selling campaigns. Efforts of the Department of Agriculture and State officials resulted in suppressing much of the fraudulent advertising and in greatly curtailing the sale of Grohoma seed at high prices. The fake grafting process on sorghums was detected. Exploiters attempted to retaliate against Department and State officials for exposing the fraud by using political and legal methods but were unsuccessful. (*Author's abstract.*)

Discussed by Messers RABER, SWINGLE, HITCHCOCK, and BRIERLY.

C. O. ERLANSON: *A resumé of potato investigations in Mexico and South America.*—The Bureau of Plant Industry sent out expeditions in 1931 and 1932 to obtain new varieties of potatoes for use in breeding new types resistant to the various virus diseases of this crop. Potato relatives, numbering about 150 species, are distributed from New Mexico and Arizona south through the mountains of Mexico, Central and South America. About 600 collections of tubers and seeds of potatoes and potato relatives were obtained from the two expeditions. This material is now being grown at several experiment stations where studies will be made as to the resistance to degeneration diseases of any promising types which develop.

Discussed by C. A. LUDWIG.

### 251ST MEETING

The 251st regular meeting was held in the Assembly Hall of the Cosmos Club October 3, 1933. President CHARLES BROOKS presided.

*Program:* J. B. KINCER: *Long-time temperature trends: Are the old fashioned winters gone?*—Attention was called to the remarkable sequences of years with supra-normal temperature, especially during the fall and winter seasons, which have occurred over eastern North America since 1876. Weather records for Washington, D. C., show that 18 of the last 21 winters have been warmer than normal, and that all of the last 13 have been mild; only 3 of the 25 fall seasons since 1907 have had sub-normal temperatures while 15 of the last 17 months, including September 1933, had plus departures from normal. The abnormally warm weather experienced in general for a long time past does not mean, however, that cold periods have been entirely absent. The records indicate that occasional brief spells of abnormally cool, or extremely cold, weather are characteristic of prevailingly high temperature trends. The cold winter of 1917–18 coming at a time when the long-time trend was running comparatively high was cited as an example, and also the fact that the lowest official temperature on record for the United States—66 degrees below zero—occurred in the Yellowstone National Park in February, 1933.

Discussed by W. A. TAYLOR and M. B. WAITE.

H. H. MCKINNEY: *Time of sexual reproduction in wheat as influenced by temperature and light.*—Shoot development and flower differentiation in the wheat plant are affected by temperature and length of day. Winter wheats are low-temperature short-day plants during leaf and tiller formation, and high-temperature, long-day plants during elongation and heading. The low temperature requirements for earliness in winter wheat can be met during the early stages of germination by exposing partly germinated seeds at 35–38° F. for 65 days. The treatment called iarovization by the Russians, and vernalization by the English, may be carried out in either darkness or light. By its means heading of wheat may be significantly advanced.

### 252ND MEETING

The 252nd regular meeting was held in the Assembly Hall of the Cosmos Club on November 7, 1933. President CHARLES BROOKS presided.

*Program:* W. W. DIEHL: *The lack of chlorosis in some sterility diseases of grasses.*—The effect upon certain grasses of a systemic infection produced by certain parasites recognized in the genera, *Myriogenospora*, *Dothichloë* and *Balansia* is to produce a partial or complete sterility, unaccompanied, however, by any chlorotic condition, since diseased plants and organs are of a normal green color. Dependent upon the particular combination of host and parasite there may be a dwarfing or an invigoration of the diseased plant. The examples which were chosen to illustrate these conditions were as follows: *Andropogon virginicus* infected by *Myriogenospora; Aristida glauca, Sacciolepis striata, Panicum clandestinum, and Sporobolus berteroanus* infected by *Dothichloë; Cenchrus echinatus* infected by *Balansia claviceps;* and *Danthonia* spp. infected by *Balansia Hypoxylon.* (*Author's abstract.*)

J. R. MAGNESS: *The functioning of fruit trees as influenced by moisture supply.*—When a portion of the root zone of apple trees reaches the wilting percentage, the daily period of stomatal opening becomes reduced. Under extreme water shortage, stomata fail to open at any time during the day. Rate of fruit growth is closely correlated with the moisture condition and stomatal behavior. When sufficient moisture becomes available following drought conditions, leaf function and fruit growth are apparently resumed

at a normal rate. Under conditions of water shortage, the starch-sugar ratio in bark and wood is modified, tissue from trees under moisture shortage containing more sugar and less starch than under ample moisture supply. Total carbohydrates manufactured as well as total starch in the tree are reduced by water shortage. Fruit bud formation apparently is increased by the water shortage associated with high soluble carbohydrate content in the tissues. (*Author's abstract.*)

Discussed by L. E. YOCUM and M. B. WAITE.

### 253RD MEETING

The 253rd regular meeting was held in the Assembly Hall of the Cosmos Club, December 5, 1933, President CHARLES BROOKS presiding.

*Program:* Address of retiring President CHARLES BROOKS: *After-harvest botany—Some botanical aspects of perishable food products.*—This address will be published in The Scientific Monthly.

### 33RD ANNUAL MEETING

The 33rd annual business meeting and election of officers was held following the adjournment of the 253rd meeting.

The recording secretary reported 8 regular meetings and one outing during the year. The annual dinner was held in March at Meridian Mansions. The average attendance at the regular meetings was 87. Thirteen new members were elected, two absent members reinstated, two active members placed on the non-resident list, and four members lost by resignation. Dr. J. A. FARIS died September 24th. The active membership is 213. Three members, W. H. EVANS, V. K. CHESTNUT, and W. W. EGGLESTON, who retired during the year, were elected to honorary membership.

The following officers were elected: *President*, NATHAN R. SMITH; *Vice-President*, W. W. DIEHL; *Recording Secretary*, FREEMAN WEISS; *Corresponding Secretary*, ANNA E. JENKINS; *Treasurer*, NELLIE W. NANCE; *nominated as Vice-President of the Washington Academy of Sciences*, CHARLOTTE ELLIOTT.

CHARLOTTE ELLIOTT, *Recording Secretary.*

## SCIENTIFIC NOTES AND NEWS

*Prepared by Science Service*

### NOTES

*CWA aids American archaeology.*—CWA archaeological projects in five states, under the guidance of the Smithsonian Institution, are yielding new data in American archaeology. An old Indian burying ground explored in Kern County, Calif., has revealed grave posts of extraordinary importance. The wooden posts may enable archaeologists to establish some definite dates, thus turning prehistory into dated history in California. The posts are of cedar or juniper wood. Old as they are, annual growth rings in the wood are well preserved. It is hoped that by comparing the rings with the long calendar of annual rings shown in California redwood trees, the years when the grave posts were cut and made can be determined. The California Indians whose age may be learned were buried with few possessions. The excavators have found 150 burials, wrapped in cloth and matting, in the graveyard.

CWA workers near Murphy, N. C., have excavated an Indian mound and

identified the site as a Cherokee village visited by the Spanish explorer De Soto. It is called "Guasili" in the Spanish records. Another Indian village which De Soto may have visited is being explored at Bradenton, Fla. European glass beads suggest that the Spanish gold-seeking expedition tarried there, and exchanged beads for information, hospitality, or supplies.

A large mound being explored by another CWA group in Macon, Ga., is proving far more extensive than had been expected. Near the top, the digging has disclosed evidence of European contact. More deeply buried are phases of aboriginal cultures, some belonging to historically known tribes. From pottery fragments, the archaeologists see indications that these Georgia Indians had contacts with tribes farther north.

In Tennessee, the CWA workers are still seeking to identify Indians who built the numerous mounds in Shiloh National Military Park.

*Photographic map of Indian lands.*—A huge airplane photographic map, 40 by 24 feet, of the Navajo and Zuni Indian lands in New Mexico, Arizona, and Utah has been contracted for by the Department of the Interior. It is to be used as a basis for the better regulation of grazing practises, which have already gone to severely damaging excess in many small areas and a few large ones.

Airplanes making the photographs will fly at an altitude of over 20,000 feet, taking more than 4,500 individual photographs with a special four-lens camera. The separate pictures will be fitted together into a single mosaic map. The total cost of the work will be about $77,000; but if the work were done by ground parties it would cost more than $500,000.

*A new deal for ducks.*—Secretary of Agriculture WALLACE, with the approval of President ROOSEVELT, has appointed a committee to outline a course of action under a proposed plan for enlarging areas on which game birds can be fed and bred. The first projects will be for the restoration of the feeding grounds of ducks and other migratory game birds, including the reflooding of unprofitable "reclaimed" swamp and lake lands, the renewal of natural food supplies, cover and nesting sites, and the protection of the birds from natural enemies and illegal hunters. Correlated with the lowland projects is a program of reversion to brush and timberland of upland areas in the submarginal agricultural class, giving cover for non-migratory upland game birds and mammals. These can be handled at least partly on a "game farming" basis by the landowners. The cost of the program, it is proposed, shall be met in part through a low Federal hunting license fee, together with a small tax on hunting ammunition.

*Fish cultural survey of Puerto Rico.*—On January 25 Dr. S. F. HILDEBRAND senior ichthyologist of the U. S. Bureau of Fisheries, sailed from Baltimore for Puerto Rico to conduct a survey of the fish cultural possibilities of the island.

On the occasion of his visit to the United States Mr. R. MENENDEZ RAMOS, Commissioner of the Department of Agriculture and Commerce of Puerto Rico, requested the assistance of the Bureau of Fisheries in assessing the possibilities of developing trout culture in the high mountain streams and in several reservoirs of the northern watershed on the island, as well as the possibility of propagating and stocking the lower reaches of the streams with other food and game fishes. The Puerto Rican Government is cooperating in the survey by defraying the field expense of the investigation, and the Bureau is furnishing the services of the investigator.

## News Briefs

The third Arthur Lecture was given by Dr. Charles G. Abbot, secretary of the Smithsonian Institution, in the hall of the U. S. National Museum on the evening of February 26. The subject was, *How the sun warms the earth.*

The American Academy of Tropical Medicine was founded at a conference held at the National Academy of Sciences on February 5, under the auspices of the National Research Council. Dr. Theobald Smith was elected its first president.

The U. S. Public Health Service has received advices from Manchukuo indicating that the United Anti-Plague Commission has been re-established as a permanent organization.

Greater refractivity of the lower layers of the atmosphere during periods of profound calm may be due to the "settling to the bottom" of the heavier isotopes of oxygen, sorted out by differential gravitation, L. W. Tilton of the National Bureau of Standards, has suggested in a communication to *Nature.*

James A. Ford of the Smithsonian Institution has discovered a mound-builder dwelling site near Marksville, La., with clearly marked post-holes giving dimensions and general architectural plan. Though far from the traditional Hopewell country, it seems to belong to the Hopewell culture type.

Public attention was directed to a widespread incidence of measles by the U. S. Public Health Service, on February 7. Measles outbreaks seem to run in cycles of about two and one-half years, it was pointed out; and this is apparently the peak of a cycle.

Radio talks under the auspices of Science Service were broadcast over the network of the Columbia Broadcasting System, by F. A. Silcox, chief forester, U. S. Forestry Service, on January 31, and by Dr. Vincent du Vigneaud of the faculty of the George Washington University School of Medicine, on February 7.

A number of mallard ducks have been donated to the Office of National Parks, Buildings and Reservations of the U. S. Department of the Interior and placed on Roache's Run on the Mount Vernon Boulevard. It is believed that this will form the nucleus of a bird sanctuary at this point which will undoubtedly attract many Washington visitors. A report made February 9 says that the original 27 pairs planted at this point had attracted a considerable number of other ducks. The total number is now in excess of 250.

The Secretaries of the Interior and Agriculture each have appointed two men within their Departments as members of a committee of five, the fifth member being the chairman, Mr. Jacob Baker, to assemble and recommend lands to be acquired in connection with a program for the purchase of submarginal lands with $25,000,000 made available through the Public Works Administration.

On January 15 the five district officers in the United States having charge of State Park Emergency Conservation Work met in the office of assistant director Conrad L. Wirth of the Office of Public Parks, Buildings and Reservations, U. S. Department of the Interior, for the purpose of discussing

general organization plans and work to be carried on in State Park Emergency Conservation work camps during the third enrollment period. This period will start next April 1 and extend to March 31, 1935, provided Congress appropriates the necessary funds.

Dr. G. W. WAIT, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, broadcast a talk entitled *Electricity in the atmosphere* on January 30 from Station WMAL under the auspices of the Greater National Capital Committee of the Washington Board of Trade.

## PERSONAL ITEMS

Capt. ALBERT W. STEVENS, U. S. Army Air Corps, has been awarded the Franklin L. Burr prize of the National Geographic Society in recognition of his work on aerial photography, particularly his photograph from 20,000 feet altitude of the moon's shadow during the total solar eclipse of 1932.

PAUL G. REDINGTON, chief of the Bureau of Biological Survey and F. C. LINCOLN, who is in charge of the Bureau's bird-banding work, attended the joint meeting of the Northeastern Bird-Banding Association and the Federation of the Bird Clubs of New England, held in Boston, on January 19.

O. J. MURIE, Biological Survey field naturalist stationed at the Elk Refuge in Wyoming, is in Washington conferring with Bureau officials on matters pertaining to his studies of the elk of Jackson Hole, Wyo.

Assistant Director HAROLD C. BRYANT, assistant to the superintendent of Yellowstone National Park JOSEPH JOFFE, and Mr. DAVID E. MADSEN of the Wild Life Division, represented the Office of National Parks, Buildings, and Reservations, U. S. Department of the Interior, at the American Game Conference held in New York City the latter part of January. Former Director HORACE M. ALBRIGHT also attended. In connection with this conference a special meeting of the Commission on the Conservation of the Elk of Jackson Hole was held, at which Mr. JOFFE was appointed secretary to succeed Mr. OVID BUTLER.

W. E. EMLEY, chief of the organic and fibrous materials division of the National Bureau of Standards, addressed the Board of Directors of the General Federation of Women's Clubs in Washington on January 11, in regard to consumers' specifications for hosiery. Mr. EMLEY also addressed the annual meeting of the National Association of Dyers and Cleaners in Chicago on January 17 and presided at a meeting of the Research Committee of the U. S. Institute for Textile Research in Washington on January 20.

W. D. APPEL, chief of the textile section of the National Bureau of Standards, attended a meeting of the shrinkage committee of the American Standards Association in New York on February 1. This committee is considering the adoption of an American standard for measuring the shrinkage of fabrics.

On January 2, Dr. FREDERICK A. DAVIDSON, associate aquatic biologist of the Bureau of Fisheries, was appointed by the commissioner to serve as acting director of the Fisheries Biological Laboratory at Seattle, Wash., relieving JOSEPH A. CRAIG, who has been serving as director since October 7, 1931.